Space Weather Technical Forecast

Issued on Friday, 09 February 2024 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Moderate activity likely with isolated M-class flares/R1-R2 Radio Blackouts. Chance of isolated X-class flares/R3 Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with isolated M-flares, the peak flare a M3.9 at 08/2355 UTC from AR3575 over the western limb. There are currently ten numbered sunspot regions on the visible disc, however the majority of these are small and relatively simple. AR3576 remains a large and magnetically very complex region in the southeast, with a classification of Fkc/Beta-Gamma-Delta. Magnetic looping is evident in SDO imagery between this region, and several other regions on the southeast disc in close proximity to AR3576. AR3575, which has been responsible for much of the activity over the last couple of days, has passed over the western limb, but flaring is still evident in imagery.

No Earth-directed CMEs have been observed during the past 24 hours, but a filament eruption from centre disc around 08/2100UTC, an earlier CME from the southeast and the recent M3.9 flare will need further analysis once imagery becomes available.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1 are currently around 470 km/s and have predominantly been at slightly elevated levels over the last 24 hours, with occasional periods of elevated wind speeds early in the period. Density has been below average throughout. The Interplanetary Magnetic field (IMF), Bt, was weak, at or below 6nT, and the north-south component Bz, has fluctuated weakly. Phi angle was mostly positive (away from the Sun), but became negative (towards the Sun) around 08/2100UTC. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux remained at background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold and has had a flat trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity likely, with isolated M-flares and a chance of X-flares. The flare risks reduce slightly as AR3575 continues to move around the southwest limb, however AR3576 and new or returning regions maintain a likelihood of Moderate activity.

Solar Wind / Geomagnetic Activity: Wind speeds are expected to continue to decline from slightly elevated levels towards background. A CME that left the Sun on 06 Feb may provide a slight glancing blow late Day 1 (09 Feb) or early Day 2 (10 Feb). Geomagnetic activity is expected to be mostly Quiet (Kp 0-2), with a chance of Unsettled intervals (Kp 3) and a very slight chance of a G1/Minor Geomagnetic Storm interval (Kp 5), should any CME enhancement occur.

Energetic Particles / Solar Radiation: High energy proton flux has the potential to rise in response to any significant flares, most likely from AR3575 on the far side, or AR3576. High energy electron flux (greater than 2MeV) is expected to continue at low to moderate levels, with

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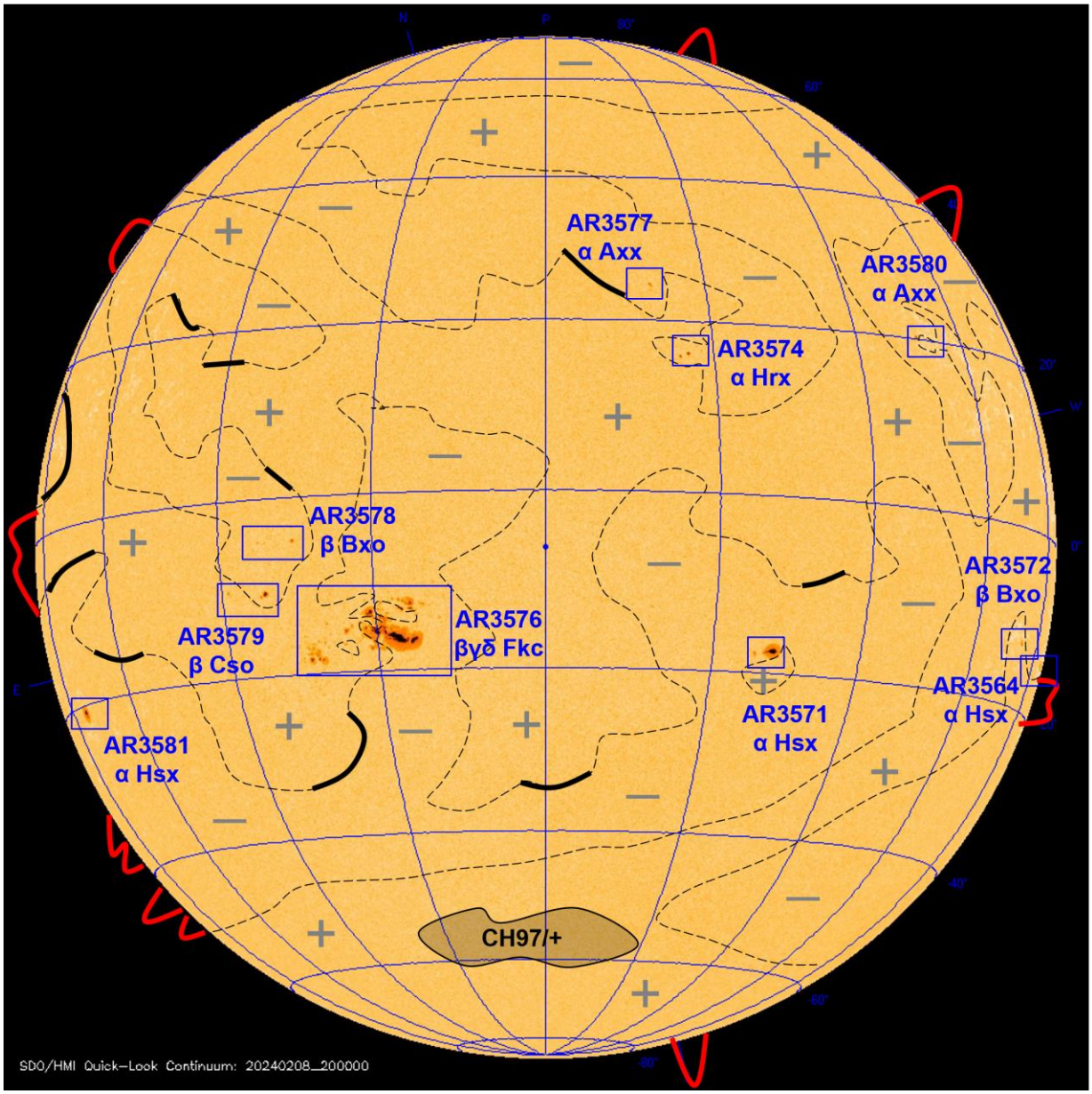
the associated 24 hour electron fluence remaining well below the Active threshold.

Figure 1. Solar Analysis Valid 08/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Solar winds are currently around 460 km/s with speeds potentially indicative of slight enhancement from a small coronal hole (CH96/+) which is now no longer visible. A gradual decline in winds is expected through days 1 and 2 (09-10 Feb). Some Enlil ensemble members indicate that a new weak HSS may arrive through Day 2, perhaps associated with CH97/+ in the southern disc, but any enhancement and geomagnetic effects associated with this low HSS are considered to be minor, with speeds remaining at, or close to, slow-ambient levels.

A CME that left the Sun in association with the M4.2 flare early on 06 Feb may give a glancing blow late today (09 Feb) or early day 2, bringing a very slight chance of a G1/Minor Geomagnetic Storm interval, in conjunction with any weak HSS influence. However, a miss is more probable. No other Earth-directed CMEs are in the current forecast, although analysis is ongoing of a filament eruption from centre-disc around 08/2100UTC and an eruption from the southeast visible in STEREO A imagery around 08/1923UTC.

Throughout the period geomagnetic activity is expected to be mostly Quiet (Kp 0-2), although there is a chance of Unsettled (Kp 3) intervals and a very slight chance of a G1/Minor Geomagnetic Storm interval (Kp 5), should any CME enhancement occur Days 1-2.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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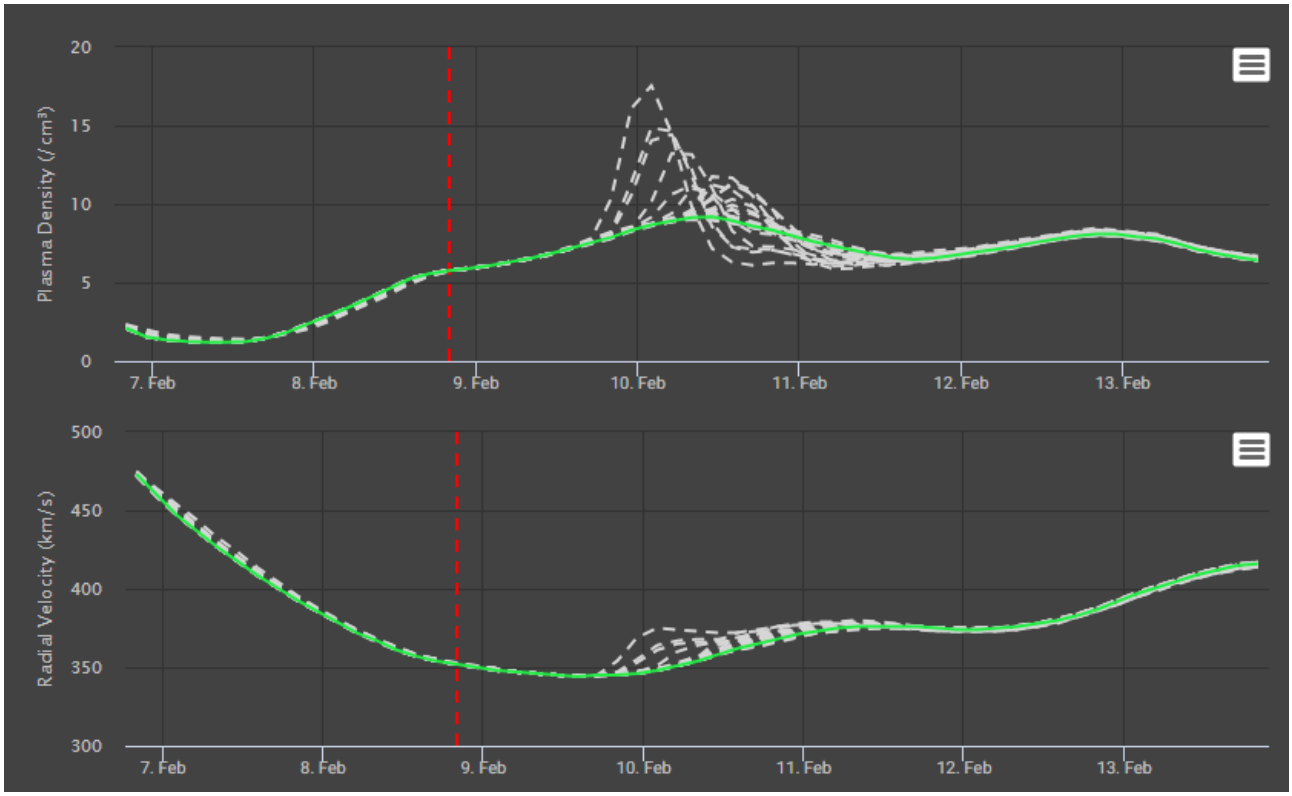
Figure 2: MOSWOC ENLIL ensemble showing some members with CME arrival late day 09 Feb or early 10 Feb. Wind speeds are currently in error, so low confidence.



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Radio Blackouts - X-Ray Flares:

There are currently ten numbered regions on the visible disc.

AR3576, in the southeast, remains the largest and most significant and complex region with asymmetrical mature penumbra and a number of delta spots, including one large delta spot in the central portion of the leading spot. Also evident on SDO-AIA imagery is broad and wide-reaching magnetic looping, connecting the region to others in the vicinity. This region continues to evolve, with the amalgamation of spots in its trailing and northern portions.

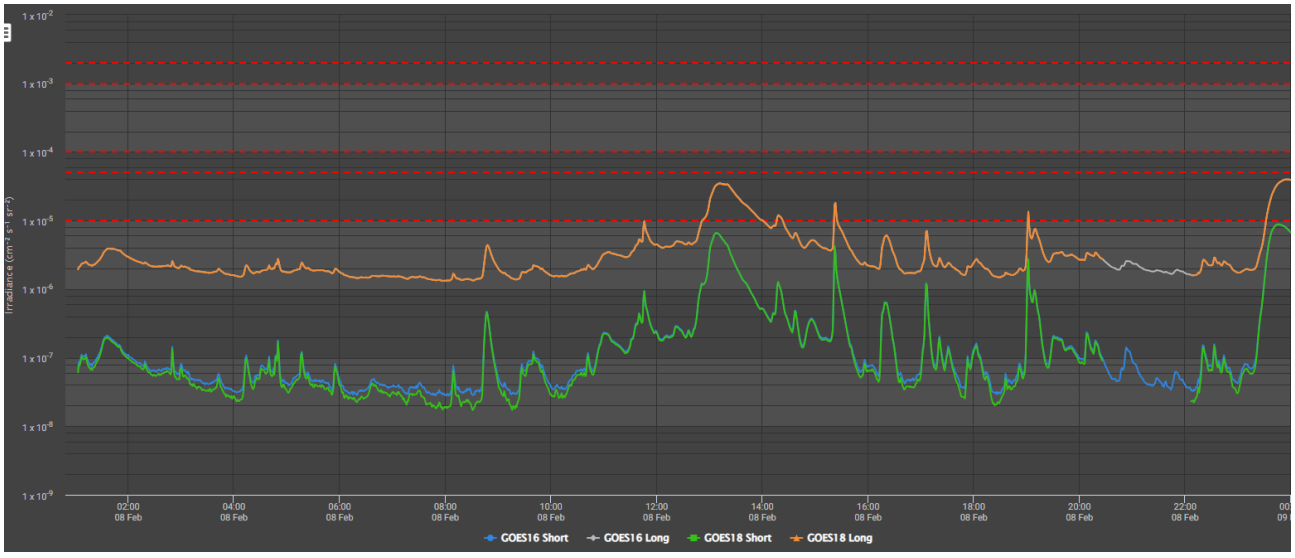
AR3575, which has been a source of activity over the last few days, has passed over the western limb and can no longer be seen, however flaring is still evident in imagery, so risks of large flares declines only slowly through the start of the forecast.

The other regions on the disc are much smaller and more magnetically simple.

Moderate activity is likely to persist with isolated M-flares and a chance of X-flares. The probabilities reduce by Day 2 as AR3575 moves further onto the far side. However, new or returning regions are expected to rotate onto the visible disc through the period, maintaining a likelihood of significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	60	60	60
Very Active	R3 to R5 X Class	No	20	15	15	15

Figure 3: GOES16/18 X-Ray Flux



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Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently at background levels. The high energy proton flux has the potential to rise in response to any significant flares, most likely from AR3575 or AR3576, with significant flares from these regions giving a chance of exceeding the S1/Minor Radiation Storm level. The probabilities of this decline only slowly as AR3575 continues to present a threat from geoeffective locations around the western limb. AR3576 will cross into the western hemisphere around day 3 (11 Feb), gradually moving into a more geoeffective location with regard to protons.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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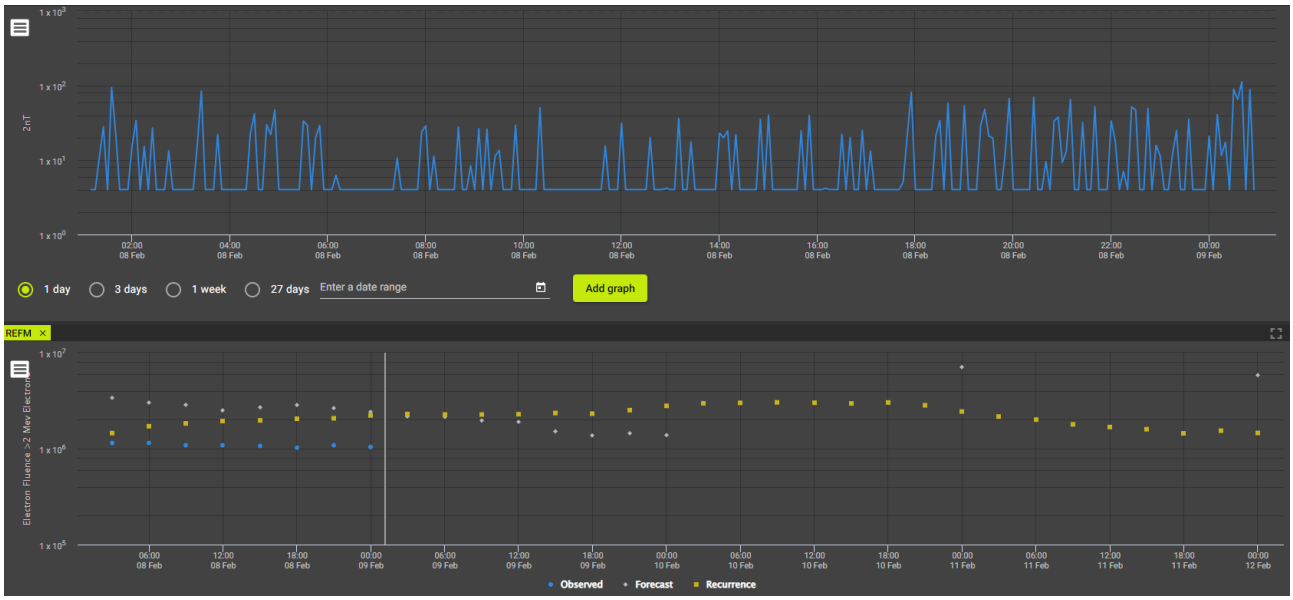
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 is expected continue at generally low to moderate levels, likely becoming mostly moderate by the end of the period. No appreciable connection to coronal hole high speed streams is expected through the period, with only negligible effects on the electron flux level. Several MOSWOC Enlil ensemble members indicate that a new weak HSS may arrive through Day 2 (10 Feb) but this is considered low likelihood and low confidence.

The associated 24 hour electron fluence is expected to remain well below the Active (1e8 integrated flux) threshold, as suggested by MOSWOC's REFM, which is currently thought to be giving good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: GOES16 Electron Flux (top) and MOSWOC REFM (bottom)



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